Blood salvage during Caesarean section

M. P. RAINALDI, P. L. TAZZARI, G. SCAGLIARINI, B. BORGHI AND R. CONTE

Summary

The aim of this study was to assess blood salvage during Caesarean section. In 15 Caesarean sections, red cells lost were collected and washed with a Dideco machine and tested for the presence of fetoplacental material, bacterial contamination, free haemoglobin and fetal blood cells. Successive patients were allocated randomly to one of two groups. In group 1 (n=34), intraoperative blood was salvaged, while group 2 served as a control. The mean amount of blood salvaged in group 1 was 363 (sd 153) ml. Blood was salvaged following these guidelines: identification of blood group of the mother and fetus; avoidance of aspirating blood from the umbilical cord; commencement of salvage after removing the fetoplacental unit; completely filling the centrifugation bowl with red cells; washing the cells using at least 1000 ml of physiological solution per bowl; and mixing the contents of the bowl, completely eliminating theuffy coat where fetal cells are located. In group 1, the use of homologous blood transfusions was significantly lower (one of 34 (2.9%) patients compared with eight of 34 (23.5%); P = 0.01). Haemoglobin concentrations during the first 4 days after operation were significantly higher approximately 3 h after surgery mean haemoglobin concentrations were 8.6 (1.2) g dl⁻¹; P < 0.0001), while after surgery mean haemoglobin concentrations were significantly higher approximately 3 h after operation compared with the control (10.2 (1.5) vs 8.6 (1.2) g dl⁻¹; P < 0.0001). On the first day, haemoglobin concentrations were 9.8 (1.5) vs 8 (1.4) g dl⁻¹ (P < 0.0001), on the second day 9.8 (1.4) vs 7.7 (1.4) g dl⁻¹ (P < 0.0001), on the third day 10.1 (1.5) vs 7.5 (1.3) g dl⁻¹ (P < 0.0001) and on the fourth day 10.4 (1.5) vs 8.1 (1.4) g dl⁻¹ (P < 0.0001). (Br. J. Anaesth. 1998; 80: 195–198)

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Counselling of pregnant women on the possibility of autologous blood donation before delivery to avoid any risk to the fetus is unusual.¹ Long-term freezing of autologous blood is possible, but this is not readily available for every pregnant woman. Thus in selected patients undergoing Caesarean section, it may be useful to ascertain the possibility of re-infusing intra-operatively salvaged blood, providing there is evidence that recovered red cells are devoid of contaminants, and major antigenic incompatibilities are avoided (ABO, Rh, Kell). Some studies have been reported: in 1989 a French group described blood salvage in 15 patients undergoing Caesarean section using the Hemonetics “Cell Saver 4” which washes cells without mixing the contents of the bowl.² The results showed that: free Hb increased by 20-fold; cultures for Epidermis staphylococcus were positive; fetal red cells were present in 20% of cases; and fetal lanugo and scales were found in one case.

Between 1989 and 1991 at Buon Samaritano Hospital, San Jose (CA, USA), four patients giving birth received a total of 9 u. of washed and salvaged blood without amniotic embolism or other complications attributed to re-infusion.³

The aim of this study was to assess blood salvage during Caesarean section and the effect of this procedure on perioperative haemoglobin concentrations and postoperative hospital stay.

Patients and methods

All patients gave written informed consent to the study which was approved by the Ethics Committee of the hospital. We studied 68 patients, mean age 32.7 (16–43) yr, body weight 72.5 (sd 11.6) kg and height 160.4 (5.7) cm who were allocated randomly to one of two groups. In group 1 (n=34) mean age was 33.6 (22–43) yr, body weight 73.3 (sd 12.8) kg, height 161 (sd 5.9) cm, and blood lost during surgery was re-infused. In 17 cases of maternofetal blood group incompatibility, blood was re-infused after ensuring that no fetal blood was present. In group 2 (n=34), mean age was 31.9 (16–41) yr, body weight 71.6 (sd 10.5) kg, height 160 (5.5) cm, and intraoperative blood loss was not salvaged.

In 43 patients the anaesthetic technique used was combined spinal extradural anaesthesia (elective surgery; 22 patients in group 1), in 12 spinal (urgent; six patients in group 1) and in 13 general anaesthesia (six patients in group 1; extremely urgent).

Blood was salvaged using the Dideco machine (Mirandola, Modena, Italy) which provides good
quality washing because red blood cells can be mixed in the bowl during washing. In order to limit contamination, blood salvage was started after extraction of the fetoplacental unit (i250.e. during the most “bloody” but “cleanest” phase of the operation when the uterine cavity was open with the blood vessels gaping). Blood enters the aspirator where salvaged blood is mixed with anticoagulant solution (ACD formula A) then, through the connection tubes, to a reservoir where is passes through a 40-micron filter.

An adjustable speed peristaltic pump discharges anticoagulated blood to the centrifugation bowl where it is washed with isotonic solution and concentrated. The best quality wash is obtained by alternating washing the red blood cells with mixing the bowl contents and reducing centrifugation speed to less than 1000 rpm.

To assess the quality of these red cells, in 15 patients blood was salvaged, not re-infused, but subjected to a series of quality tests.

- (1) Culture and microbiological tests.
- (2) Free haemoglobin in supernatant blood using the Technycon Bayer H2 optic laser globule counter and a photometric method.
- (3) Evaluation of fetal haemoglobin with the HPLC DIAMAT (Biorad) automatic system (20 μl of haemolysed blood were introduced in the cationic exchange silica gel chromatographic column which separates haemoglobin by tannons with progressively increasing ionic strength and pH, enabling elution of haemoglobin by the column at a precise, standard time). Fetal haemoglobin elutes at 3.5 min and a filtered photometer reads the fractions eluted at 415 and 690 nm and a computer performs the integration of the chromatogram peaks.
- (4) Microscopic slide examination of blood salvaged and washed, and stained using the May–Grunwald–Giemsa method.
- (5) Assessment of procoagulant activity of placental origin in the supernatant from salvaged and washed blood. The whole of each sample was tested after microfiltration (this liquid was added in equal parts to a pool of normal plasma). The results were compared with those obtained by adding, in the same proportion, tampon PBS pH 7.4 to the pool of normal plasma. Three different tests were: addition of CaCl2 0.025 mol litre−1, addition of kaolin 5 g litre−1 and addition of APTT reagent diluted 1:50 (containing homogenized human platelets and kaolin).

(6) Fetal red blood cell contamination evaluated by cytofluorimetry for fetomaternal incompatibility (ABO, Rh). In these cases, fetal haemoglobin was not determined.

(7) Assessment of blood groups. EDTA-containing samples from mother and umbilical cord (fetus) were analysed immediately after delivery for A, A1, B, D, C, c, E, e, K and k antigens using standard methods (Kell-incompatibilities were not found).

(8) Evaluation of the presence of fetal red blood cells in salvaged blood in case of ABO or Rh incompatibility, or both. Erythrocyte antigen expression was studied by immunofluorescence and flow cytometry and different polyclonal antisera were used, according to the fetal antigenic mosaic.

In 17 patients with ABO incompatibilities, we used hyperimmune anti-A and anti-B antisera with an IgG titre >1:512 diluted appropriately in saline; in patients with Rh incompatibility, the following reagents were used: anti-D (Ortho Diagnostic System, Raritan NJ, USA) and anti-D, anti-c, anti-C, anti-c anti-E and anti-e (A. Menarini Diagnostici, Firenze, Italy). All antisera were approved for slides and test tubes. Fluorescein–isothiocyanate conjugated rabbit anti-human IgG immunoglobulins were used as a second-step reagent.

A standard immunofluorescence technique was used, as described previously. The fluorescence intensity of each sample was evaluated using a Coulter EPICS XL-MCL cytofluorimeter (Coulter, Hialeah, FL), equipped with a 488 nm air-cooled argon laser. An electronic bit-map gating for red blood cells was set by combining forward scattering (log scale) with 900 light scattering (linear scale) and the percentage of positive erythrocytes was evaluated both by histograms with log-integrated green fluorescence, plotted against the number of red cells counted (10 000 at least) and by plotting green fluorescence analysis against forward scattering. Histograms and MCV values were generated by the standard software of the EPICS XL-MCL-dedicated computer.

Indications for Caesarean section, co-existing diseases, perioperative haemoglobin concentrations, intra- and postoperative complications, and duration of hospital stay were recorded for all patients (tables 1, 2). Statistical analysis was carried out using contingency table tests, Fisher’s test, ANOVA and the Mann–Whitney test.

**Results**

Our quality tests on salvaged blood revealed that: the culture and microbiological tests were negative; fetal haemoglobin was absent, except in three patients in which it was 1.8–2.0%. In these three patients fetal haemoglobin was also present in maternal blood (1.5–1.8%) which confirms transplacental passage of fetal haemoglobin during pregnancy; free haemoglobin was virtually absent (mean 0.05 (SD 0.06) mg %); fetoplacental material was not observed on
Blood salvage during Caesarean section

Changes in haemoglobin (Hb) concentration in the two groups. Postop. = 6 h after surgery.

Table 3 Use of homologous red blood cells (HRBC) and duration of postoperative hospital stay (number (%) or mean (s)) in both groups

<table>
<thead>
<tr>
<th></th>
<th>All patients</th>
<th>Blood salvage</th>
<th>No blood salvage</th>
<th>ANOVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>No HRBC patients</td>
<td>59 (86.7%)</td>
<td>33 (97%)</td>
<td>26 (76.5%)</td>
<td></td>
</tr>
<tr>
<td>HRBC patients</td>
<td>9 (14%)</td>
<td>1 (2.9%)</td>
<td>8 (23.5%)</td>
<td>P = 0.0001</td>
</tr>
<tr>
<td>Postop. hospitalization</td>
<td>6 (2.9%)</td>
<td>5.3 (1.9%)</td>
<td>7.3 (4)</td>
<td>P = 0.003</td>
</tr>
<tr>
<td>(days)</td>
<td>[3–12]</td>
<td>[5–21]</td>
<td></td>
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</tbody>
</table>

Figure 1 Changes in haemoglobin (Hb) concentration in the two groups. Postop. = 6 h after surgery.

microscopy. Leucocytes and cell fragments were detected only in cases where the buffy coat had not been eliminated completely; and study of procoagulant activity in salvaged blood revealed a normal recalcification time in 13 of 15 patients. In two samples, where during salvage the buffy coat was not removed totally because of incomplete filling of the bowl, recalcification time was shortened (compared with the pool and tampon). This shortening was eliminated by removing the fragments of lysed cells (red cells, white cells, amniotic cells) and filtration of the supernatant.

The presence of fetal blood, tested by cytofluorimetry in all cases with maternofetal blood group incompatibility, was found in a quantity of 0.8–1.4% in four patients who did not receive re-infusion of blood. The cause of this contamination was errors in carrying out the salvage procedure, such as aspiration of blood from the umbilical cord and incomplete removal of the buffy coat in the washing technique produced by incomplete filling of the bowl.

The two groups were similar in age, height and body weight. The mean amount of blood salvaged in the 34 patients who underwent re-infusion was 363 (SD 153) (range 125–800) ml. Mean packed cell volume of re-infused red blood cells was 62 (SD 5) %. Five days after surgery, one of these patients received transfusion of 2 u. of homologous blood because of persistent anaemia (with symptoms of dizziness on assuming an upright position). In the second group, eight patients received homologous blood transfusions between the first and fifth day. The use of homologous transfusions (table 3) was significantly different in the two groups (contingency tables with Fisher’s test, P = 0.01).

In patients in whom blood salvage was carried out, mean basal haemoglobin concentrations were significantly lower than those in group 2 patients (ANOVA, P = 0.001), while mean postoperative haemoglobin concentrations 3 h after surgery, on day 1, 2, 3 and 4 after operation were significantly higher (ANOVA, P < 0.0001) (fig. 1).

Postoperative complications in group 1 included cystitis with pyrexia (one patient) and subfascial parietal haematoma (one patient). In group 2, complications included hyperpyrexia after transfusion of homologous blood following persistent mild fever and discharge against the doctor’s advice (two patients), and pulmonary oedema and ascites needing intensive care for 4 days (one patient). There were no complications as a result of re-infusion of salvaged blood cells.

With regard to postoperative hospital stay (table 3) because the SD value in the two groups differed considerably, ANOVA could not be used, and therefore the mean rates of the Mann–Whitney tests were used. This test revealed that hospital stay was significantly shorter (P = 0.003) in group 1.

Discussion

We have demonstrated that in the absence of contaminants and antigenic incompatibilities caused by fetal red blood cells, salvaged blood was re-infused safely.

The increasing use of surgery in childbirth and the subsequent need for blood transfusion, together with patients’ reluctance to receive homologous blood transfusions, is posing problems for the anaesthetist. Predepositing blood is still experimental and not performed routinely in obstetric surgery for several reasons: (1) fear of removing excess amounts of blood because of possible repercussions on uterine and fetal activity, as reported in the literature; (2) varying degrees of anaemia in at least 50% of cases; (3) difficulty in predicting the date of childbirth, even by surgical intervention (planned Caesarean section brought forward because of concerns regarding fetal wellbeing); and (4) limited usefulness in patients with severe haemorrhage.

Acute preoperative isovolaemic haemodilution is difficult to perform because of the physiological haemodilution present in the pregnant patient. We observed a higher postoperative haemoglobin concentration in patients who underwent intraoperative salvage and this confirms the findings of Orr and Blenko, who reported a higher osmotic resistance than homologous banked blood cells, and McShane and colleagues, who observed a higher concentration of 2,3 diphosphoglycerate, a more physiological concentration of potassium and pH, and a higher content of haemoglobin in blood washed with the Dideco Autotrans BT 795 compared with donated blood. Later, Alleva and colleagues reported less damage to red cells salvaged during operation with the Dideco STAT and cells recovered after operation with the Dideco BT 797 Recovery compared with cells predeposited in SAG-M and preserved in the refrigerator for 21 days at 4 °C. We conclude that blood salvage may be useful to avoid autologous blood transfusion and it may be associated with a better outcome and shorter hospital stay.

Blood salvage during Caesarean section may be performed according to these guidelines: determine the blood group of the mother and fetus; avoid aspiration of blood from the umbilical cord; start salvage after removing the fetoplacental unit; completely fill
the centrifugation bowl with red cells; wash the cells accurately using at least 1000 ml of physiological solution per bowl; and mix the contents of the bowl completely to eliminate the buffy coat where fetal cells are located.

By following these guidelines we have obtained salvaged blood without fetal red cells or with minimal contamination of fetal elements, which may be re-infused even when maternofetal blood groups are incompatible.

If a pregnant woman is transfused with homologous blood at the end of delivery there is a risk of receiving incompatible Fy and Jk antigens. The highest estimated contamination of fetal blood, if present, in our procedure should be about 3 ml, which is in the range of spontaneous fetomaternal haemorrhage. Thus in our study the risk of alloimmunization from the presence of fetal red cells in salvaged blood is as likely as in a normal delivery and problems caused by administration of homologous blood is avoided. Moreover, where fetomaternal D-antigen incompatibility exists, giving the patient Rh immune globulin (300 µg) may prevent sensitization to 15 ml of packed D positive red blood cells.

References